

## CLAIMS

We claim:

~~1. A method determining positional information about an anatomical feature within a patient's body comprising the steps of:~~

~~inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting an image out of the patient's body;~~

~~designating an anatomical feature of interest;~~

~~transmitting an image of the designated anatomical feature out of the patient's body;~~

~~determining positional information about the designated anatomical feature of interest by using image processing.~~

~~2. A method of determining positional information about an anatomical feature, as in Claim 1, where the anatomical feature is designated by pointing with a second surgical instrument having a visual target.~~

~~3. A method of determining positional information about an anatomical feature, as in Claim 1, where the anatomical feature is designated by manipulating a computer generated graphics object displayed on a video screen superimposed on the image transmitted by the first surgical instrument.~~

~~4. A method of determining positional information about an anatomical feature, as in Claim 3, where the computer generated graphic object is manipulated by the use of a joystick mounted on a surgical instrument.~~

~~5. A method of determining positional information about an anatomical feature, as in Claim 3, where the computer generated graphic object is manipulated by the use of a force sensing device mounted on a surgical instrument.~~

~~6. A method of determining positional information about an anatomical feature, as in Claim 1, where the information is provided to a surgeon.~~

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~~7. A method of determining positional information about an anatomical feature, as in Claim 6, where the information is provided to the surgeon in the form of synthesized speech.~~

~~8. A method of determining positional information about an anatomical feature, as in Claim 6, where the information is provided to the surgeon in the form of tactile feedback.~~

~~9. A method of determining positional information about an anatomical feature, as in Claim 6, where the information is provided to the surgeon in the form of a computer generated graphics object superimposed on an image obtained from the first surgical instrument.~~

~~10. A method of determining positional information about an anatomical feature, as in Claim 8, where the tactile feedback is provided in the form of vibrations on a surgical instrument held by the surgeon.~~

~~11. A method of determining positional information about an anatomical feature, as in Claim 9, where the computer graphics objects are displayed in two dimensions.~~

~~12. A method of determining positional information about an anatomical feature, as in Claim 9, where the computer graphics objects are displayed in three dimensions.~~

~~13. A method of determining positional information about an anatomical feature comprising:~~

~~inserting a first and a second surgical instrument into the patient's body, each instrument having a means for transmitting an image out of the patient's body;~~

~~obtaining a first image of the feature from a first vantage point using the first surgical instrument;~~

~~obtaining a second image of the feature using the second surgical instrument from a second vantage point, the second vantage point being at a known position and orientation with respect to the first vantage point;~~

~~locating the anatomical feature in both images;~~

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~~computing the position of the anatomical feature relative to the vantage points using positional information about the feature in each image, together with the known position and orientation of the two vantage points with respect to each other.~~

14. A method of determining positional information about an anatomical feature, as in Claim 13, where the anatomical feature is located in at least one of the images by computer image processing.

15. A method of determining positional information about an anatomical feature, as in Claim 13, where the first vantage point is the position of the first surgical instrument, being one lens of a stereoscopic camera, and the second vantage point is the position of the second surgical instrument, being the position of the second lens of a stereoscopic camera.

16. A method of determining positional information about an anatomical feature, as in Claim 13, where

the first and second surgical instruments are the same, having a means for transmitting an image out of the patient's body, where the first image of the anatomical feature is obtained by placing the surgical instrument at the first vantage point,

and

the second image of the anatomical feature is obtained by moving the surgical instrument to the second vantage point.

17. A method of determining positional information about an anatomical feature, as in Claim 13, in which the first image is obtained from a first surgical instrument placed at the first vantage point and the second image is obtained from a second surgical instrument at the second vantage point, both surgical instruments having means ~~for transmitting images out of the patient's body.~~

18. A method of controlling the position of a surgical instrument inside a patient's body, the comprising steps of:

✓ inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting an image out of the patient's body;

designating an anatomical feature of interest;

transmitting an image of the designated anatomical feature out of the patient's body;

determining precise 3D positional information about the designated anatomical feature of interest relative to the first surgical instrument;

using the positional information to reposition the first surgical instrument to a desired positional relationship relative to the anatomical feature.

19. A method of controlling the position of a surgical instrument inside a patient's body, as in Claim 18, where the positional information about the feature of interest relative to the first surgical instrument is obtained by means of image processing.

20. A method of controlling the position of a surgical instrument inside a patient's body, as in Claim 18, where the positional information about the anatomical feature of interest relative to the first surgical instrument is obtained by manipulating a graphics object superimposed on an image of the anatomical feature.

21. A method of controlling the position of a surgical instrument inside a patient's body, as in Claim 18, where the positional information is used to reposition a second surgical instrument.

22. A method of controlling the position of a surgical instrument inside a patient's body, as in Claim 18, further comprising steps of:

designating a desired position of an anatomical feature relative to images transmitted out of the patient's body by the first surgical instrument;

moving the first surgical instrument to a vantage point from which the designated anatomical feature is at the desired position in images transmitted by the first surgical instrument, the first surgical instrument remaining at a constant distance from the designated anatomical feature.

23. A method of controlling the position of a surgical instrument inside a patient's body, as in Claim 18, further comprising steps of:

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designating a desired direction of motion of an anatomical feature relative to images transmitted out of the patient's body by the first surgical instrument;

moving the first surgical instrument so that it remains at a constant distance from the designated anatomical feature while causing the motion of the designated feature in images transmitted from the first surgical instrument to move in the desired direction.

24. A method of controlling the position of a surgical instrument inside a patient's body, comprising steps of:

inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting an image out of the patient's body;

designating an increment of motion along an axis of view of the first surgical instrument, the axis defined by a line from the vantage point of the surgical instrument to the point on the patient's anatomy that appears in the center of the image transmitted by the first surgical instrument;

moving the first surgical instrument by the designated increment of motion along the axis of view, so that the point on the patient's anatomy appearing in the center of the image remains unchanged.

~~25. A system for positioning a surgical instrument relative to a patient's body, comprising:~~

~~a robotic manipulator having at least one controlled degree of freedom;~~

~~a control means for controlling the manipulator motions;~~

~~instrument holding means for attaching a first surgical instrument to the manipulator;~~

~~a surgeon input means permitting the surgeon to specify desired motions of the surgical instrument to the control means, where said input means are mounted on a surgical instrument.~~

~~26. A system for positioning a surgical instrument relative to a patient's body, as in Claim 25, in which~~

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~~the robotic manipulator has a remote center of motion distal to the manipulator mechanism;~~

~~the instrument holding means hold the first surgical instrument so that the point at which the first surgical instrument enters the patient's body is located at the center-of-motion of the manipulator mechanism.~~

27. A method of controlling the position of a surgical instrument inside a patient's body, comprising steps of:

inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting an image out of the patient's body;

transmitting an image out of the patient's body;

displaying the transmitted image on a video screen;

manipulating a computer graphics object superimposed on the video screen to designate a view of an anatomical feature;

moving the first surgical instrument to a vantage point from which an image comprising the designated view may be obtained.

~~28. A method of creating an image of an anatomical feature within a patient's body comprising the steps of:~~

~~inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting images out of the patient's body;~~

~~transmitting an image out of the patient's body;~~

~~creating a wide-angle image of the anatomical feature within the patient's body as it would appear from the vantage point of the first surgical instrument;~~

~~replacing a portion of the wide-angle image of the anatomical feature with an image transmitted by the first surgical instrument.~~

29. A method of creating an image of an anatomical feature within a patient's body, as in Claim 28, in which the wide-angle image is a computer-graphic rendering of the interior of the patient's body.

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~~30. A method of creating an image of an anatomical feature within a patient's body, as in Claim 29, in which the wide-angle image is produced from at least one image transmitted from the interior of the patient's body.~~

31. A method of creating a stereoscopic image of an anatomical feature within a patient's body comprising the steps of:

inserting a first surgical instrument into the patient's body, the instrument having a means for transmitting images out of the patient's body;

obtaining a first image of an anatomical feature as seen from a first vantage point;

placing the first surgical instrument at a second vantage point at a known displacement relative to the first vantage point;

transmitting a sequence of second images out of the patient's body, as seen from the second vantage point;

presenting the first image as the view to one eye and the sequence of second images as the view to other eye in a stereoscopic viewing system.

32. A method of creating a stereoscopic image of an anatomical feature within a patient's body, as in Claim 31, in which the first image is a computer-graphic rendering of the interior of the patient's body.

33. A method of creating a stereoscopic image of an anatomical features within a patient's body, as in Claim 31, in which the images displayed comprise computer-graphic renderings of edges extracted from the images transmitted from the interior of the patient's body.

34. A system for positioning a surgical instrument relative to a patient's body, as in Claim 25, in which the said surgeon input means comprise a joystick.

35. A system for positioning a surgical instrument relative to a patient's body, as in Claim 25, in which the said surgeon input means comprise a force sensing element mounted on a surgical instrument held by the surgeon.

~~36. A system for positioning a surgical instrument relative to a patient's body, as in Claim 25, in which the said surgeon input means are mounted on a surgical instrument which is to be inserted into the patient's body, the said input means being mounted on the portion of the instrument which remains outside the patient's body.~~

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